PAM 551.508 LOTZ

The Arctic Institute
of
North America

PRELIMINARY REPORT ON THE METEOROLOGICAL EQUIPMENT USED DURING THE USAF ELLESMERE ISLAND ICE SHELF PROJECT, 1959

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October 1959

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INTRODUCTION

The purpose of this report is to describe and discuss the meteorological equipment used during the United States Air Force (USAF) Ellesmere Island Ice Shelf Project in 1959. The present condition and location of the equipment is described, and suggestions made for the 1960 programme. A brief description is given of the meteorological programme carried out during the summer.

I am deeply grateful for the help and co-operation of Mr. Sig Falkowski, Meteorologist, Environmental Protection Research Division, Quartermaster Corps, Research and Engineering (QM.R.& E.), Natick, Massachusetts who attended the first working conference of the expedition on February 5th - 6th, 1959. I learned much in conversations with him, and with Dr. De Percin and Mr. Paul Dalrymple, also of QM.R.& E., that served me well in the field. I would also like to thank Dr. Svenn Orvig, Associate Professor of Meteorology, McGill University, Montreal for his help in planning the meteorological programme.

THE METEOROLOGICAL PROGRAMME

The initial landing was made on the Ice Rise north of Ward Hunt Island, Northern Ellesmere Island, at 0800 hours on May 17th, 1959. On May 23rd, the meteorological trailer was located on the north side of the Ice Rise, approximately three miles north of Ward Hunt Island. Ablation stakes were set out in a grid pattern on the northern edge of the Ice Rise, and the part of the Ice Shelf adjacent to it; the main meteorological station was located in the middle of this grid.

The main station was operated twenty four hours a day by myself, as meteorologist, and Private First Class Thomas Turnbull, QM.R.& E. as weather observer. Observations began at 0100 hours on June 1st, and comprised the following. At the two hourly intervals - temperature in the screen by standard thermometer, relative humidity by psychron, wind speeds and temperatures at 10 centimetres, 1 metre, 3 metres and 10 metres above the surface, sky cover and cloud type, surface wind direction, visibility and obstructions to visibility. Full synoptic observations were carried out at 0100, 0700, 1300 and 1900 hours EST, and comprised, in addition to the two hourly observations, six hourly maximum and minimum temperatures in the screen, screen temperature by thermograph, relative humidity by hygrograph, pressure by aneroid barometer and barograph and six hourly amounts of precipitation. A record was kept of the times of beginnings and endings of precipitation, and its form, and notes were made on other phenomena such as fog bows, and hoar frost accretion.

Radiation readings were also taken at the times of synoptic observations. These consisted of incoming short wave radiation, outgoing short wave radiation, albedo, net exchange radiation, and total hemisphere radiation. A continuous record of incoming short wave radiation was kept, and daily amounts of sunshine recorded.

Four ablation stakes, AS1 to AS4, were set in between the mast and the instrument shelter, and these were read every day at 0800 and at 2000 hours. Although this method of measuring ablation and accumulation is of limited use, since it does not take density changes into account, the stakes gave some indication of the day to day accumulation and ablation at the station.

The meteorological programme at the main station continued for one hundred days, up to 2300 hours on September 8th. No temperatures were read on the mast on June 1st, due to difficulties with the potentiometer. At the 2300 hour observation on June 4th, it was found that the 10 metre thermocouple wire was broken, and readings for this level were extrapolated until the wire was replaced on the following day. During the storms beginning on June 15th, the 10 centimetre anemometer was constantly drifted up and buried. Values for this period were obtained by hand anemometer. In early September, the 10 metre anemometer froze up, and readings for this were extrapolated.

The total hemisphere and net exchange radiometers could not be read when precipitation was falling. Towards the end of the season, unsatisfactory results were obtained on these instruments, and on the Eppley pyrheliometer, due to the low angle of the suns' rays. No readings were taken on the total hemisphere radiometer after August 30th.

It was found to be almost impossible to measure the snowfall during the summer. Falls of snow were usually associated with strong winds. The snow was driven horizontally over the rim of the gauge, and packed when it settled on the surface. By measuring the ablation stakes after each snowfall, by taking careful note of when the snowfall began and ended, and noting the intensity of the fall, and the size of the flakes, it was possible to come to some approximate idea of the amount of snow that fell. At best, measurements of snowfall in conditions like those experienced during the summer of 1959 is a refined form of guesswork. Every attempt was made to get an accurate estimate of the snowfall during the season, but some of the difficulties involved were insupperable.

Great difficulty was also encountered in obtaining surface snow temperatures. A thermocouple was tied to a dowel so that it rested on the surface of the snow, and an aluminum shield put over it. This shield tended to sink into the snow, press upon the thermocouple, and give a high reading. Since the level of the snow during the ablation season dropped hourly, the thermocouple would sometimes be just above the snow surface; at other times it would lie in a small pool of water. The metal shield was later replaced by a piece of "Styrofoam", and the thermocouple kept in its shadow. During high winds, this shading device blew away, and the thermocouple drifted up. Obtaining snow temperatures on a surface whose level varies as much as that of the Ice Rise is probably best done by installing a thermopile with the thermocouples set in a centimetre apart, and reading the appropriate thermocouple as it appears at the surface.

An instrument shelter was erected, and instruments installed on the crest of one of the rolls of the Ice Shelf, approximately one mile north of the main meteorological station, at the northern edge of the ablation stake grid. In addition to the screen instruments, a totalizing anemometer, and two ablation stakes, AS5 and AS6 were set up, and readings at this station began at 0800 hours on June 1st. The station was visited at 0800 and 2000 hours every day until the melt began. Daily readings ended on July 8th; after this date, the trough lakes were too dangerous to cross, and readings were sporadic. An attempt was made to reach this station at least once a week to change the charts on the thermograph and hygrograph,

and to reset the maximum and minimum thermometers. The instruments at this station were read for the last time at 1130 hours on September 7th, and then the station was dismantled.

SOURCE OF METEOROLOGICAL EQUIPMENT

Most of the meteorological equipment used during the summer of 1959 was bought through the Arctic Institute of North America (AINA). AM.R.& E. supplied some instruments. Careful note was taken of each AINA instrument, its location and disposal. No details of the QM.R.& E. instruments were supplied; a number of instruments arrived, and no instructions were given regarding their origin, serial numbers and ultimate disposition. Private First Class Turnbull assumed these instruments were his responsibility. I used only such QM.R.& E. instruments as I needed to supplement those bought by AINA, and formally handed over full responsibility for the care and disposal of the QM.R.& E. instruments to Private First Class Turnbull. In future, all instruments used in the meteorological programme should be the direct responsibility of the meteorologist in charge. Serial numbers, and other details should be given with a listing of the instruments, and instructions sent regarding their disposal. When the station was closed on September 8th, I handed back all QM.R.& E. equipment to Private First Class Turnbull; this report deals only with the disposal of AINA meteorological equipment.

INSTALLATION OF METEOROLOGICAL EQUIPMENT

The meteorological shelter at the main station was erected, and the instruments installed, between 1700 and 1800 hours on May 24th. A week was then spent in running in, checking out and adjusting the screen instruments. Dowels were drilled into the snow, and the legs of the screen lashed to them; the base of the screen was 37" above the snow surface.

The instrument shelter was supplied by QM.R. & E., and its specifications were Instrument Shelter, Meteorological S-101/UM. Order No. 24890, Phila. 54. No DA-19-129-QM-572-84(Signal Corps US Army). In this was installed Support, Instrument Shelter. MT-1426/UM Order No. 24890 USA-QM-572-133.

The shelter contained the following instruments.

One Thermograph. Ex. Signal Corps US Army (QM.R.& E.)
Man. Julien P. Friez and Sons.
Type No. ML-77. Serial No. 269
Order No. 3590-WF-43. QM.R.& E. No. EPRD 2-58

One Hair Hygrograph. Ex. AINA
Man. Henry J. Green.
Type No. 615. Serial No. H 2693.
AINA No. USAF 19(604)-3073-102-3B.

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One Standard Liquid in Glass Thermometer.
Ex. Signal Corps US Army (QM.R.& E.)
Man. Kahlsico.
Type No. ML 7. Arctic
Range -95°F to +95°F.

One Maximum Thermometer. Ex. Signal Corps US Army (QM.R.&E.)
Man. Weksler Thermometer Corp.
Type No. ML 4. Arctic Spec. MIL - T-11400
Range -33°F to +100°F.

One Minimum Thermometer. Ex. Signal Corps US Army (QM.R.& E.)
Man. Weksler Thermometer Corp.
Type No. ML 5 Arctic. Spec. MIL - T-11399
Range -95°F to +85°F.

One Psychron. Ex. AINA
Man. Bendix Aviation Corp. Friez Instruments Division.
Model No. 566-2.
Range of thermometers +10°F to 100°F.
AINA No. USAF 19(604)-3073-105

Located to the east of the trailer were the following radiation instruments.

One Beckman and Whitley Total Hemisphere Radiometer, Geir and Dunkle Type
Ex. AINA
Model H188-19 Serial No. 229
AINA No. USAF 19(604)-3073-100A.
Mounted on a box with its base 20" above the snow surface on May 25th.

One Beckman and Whitley Net Exchange Radiometer, Geir and Dunkle Type.
Ex. AINA
Model N188-19 Serial No. 220.
AINA No. USAF 19(604)-3073-100B.
Mounted on a box with its base 27" above the snow surface on May 25th.

One Eppley Pyrheliometer. Ex. AINA, from Arctic Research Laboratory, Alaska.
Serial No. 2168
Calibration, 2.39 mv. per gm. cal. per cm^2. per min.
Mounted with its base 23" above the snow surface on May 31st.

Located near the instrument shelter were the following.

One Solar Radiation Recorder (Actinograph). Ex. QM.R.&E.
Man. The Instruments Corp., Baltimore, Md.
Cat. No. 5-3850.
Serial No. 205. G 202095
Clock No. 622905.
Mounted on a box with its base 15" above the snow surface on May 25th.

One Rain and Snow Gauge. Ex. AINA
Man. Henry J. Green.
Type No. 340
AINA No. USAF 19(604) - 3073-102A.
Set in the snow with its lip 11" above the snow surface on May 25th.

Located southeast of the trailer was

Sunshine Recorder. Ex.AINA
Man. Wilh. Lambrecht.
Model No. 1605, Campbell Stokes pattern.
Serial No. 24501.
AINA No. USAF 19(604) - 3073-101.
Mounted on a box on May 28th, with its base 15" above the snow surface, orientated and levelled off.

The micrometeorological equipment was installed on a Rohn No. 7 Television tower. This was a thirty foot, triangular tower in three sections, mounted on a wooden base resting on four four-by-fours in the ice.

The micrometeorological equipment consisted of four thermocouples, and four anemometers mounted at 10 centimetres, 1 metre, 3 metres and 10 metres above the snow surface at the base of the tower on May 29th.

The 10 centimetre anemometer was set in the snow, and the 10 metre one fixed to the top of the tower. At the other two levels, the anemometers were mounted on mast clamps. Their specifications were.

Four Anemometers Ex.AINA
Man. Henry J. Green. Type No: 323-F.

At 10 centimetres	Anemometer, Serial No. A999. AINA No. USAF 19(604)-3073-103A.
At 1 Metre	Anemometer, Serial No. A1001. AINA No. USAF 19(604)-3073-103B.
At 3 Metres	Anemometer, Serial No. A1000. AINA No. USAF 19(604)-3073-103C.
At 10 Metres	Anemometer, Serial No. A998 AINA No. USAF 19(604)-3073-103D.

The leads from the anemometers were brought into the trailer, and connected to a buzzer box.

The thermocouples were attached to broomsticks, and were located approximately three feet away from the mast. The broomsticks were covered with aluminum foil, and the thermocouple wires run under this, and brought down the centre of the mast so that they did not touch the metal. From the mast they were strung on dowels, and brought into the trailer to be read.

Shields were used to shade the thermocouples. From observations of shielded and unshielded thermocouples it appears essential to shield thermocouples

in the High Arctic if radiation effects are to be avoided. On July 9th, for instance, at 0300 hours, the 10 centimetre thermocouple read 36.6°F shielded, and 43.0°F unshielded.

Shields were made up in the field, and proved quite satisfactory. Eight pieces of "Alzak" aluminum, .020 gauge, were cut into discs with a diameter of approximately 5½". Four cones were shaped, with holes in the top to allow free air circulation. The outside of the cones, and one side of the discs were polished, and the other side painted with black matt paint. The cones and discs were screwed to the end of the broomsticks, and the thermocouples set in the cone, above the disc. A gap separated the base of the cone, and the lower plate, so that the shield did not form a heat trap, and the thermocouple was shielded from direct and reflected radiation.

Leeds and Northrup copper-constantan thermocouples were used. At the 10 metre and 3 metre levels, 30 gauge wire was used, and 20 gauge at the 1 metre and 10 centimetre level. On June 4th - 5th, the 10 metre, 3 metre, and 10 centimetre lead-in wires were replaced by 16 gauge copper-constantan wire.

The lead-ins were brought into the meteorological trailer, to a low resistance switch, and read via this by a Gray potentiometer. In order to keep a steady known temperature at the terminals of the potentiometer, readings were taken through an ice water bath in a Dewar flask, in which a thermometer was set.

All radiation, mast temperatures and anemometer readings were done inside the trailer, as were pressure readings. The potentiometer used for reading the radiation instruments was a Gray Instruments Co. Model No. E3067, Serial No. 15146. It was a Geophysics Research Directorate Instrument, Serial number GRD 19732. The potentiometer used to read the thermocouples was also drawn through GRD, and was a similar model, Gray Serial number 15147, GRD number 19734. Six hourly pressure was read by aneroid barometer and barograph. The barometer used was a Wallace and Tiernan altimeter from GRD, Model No. FA181, Serial number 12079B, GRD Serial number 16757. At the beginning of the season, this altimeter and the barograph were arbitrarily set at Alerts' sea level pressure. At the end of the season, the altimeter was taken out, and checked at Thule Air Base. A correction was obtained to be applied to the pressure readings during the summer.

The barograph was bought through AINA. Manufacturer was Henry J. Green, Model number 565, and Serial number B808. The AINA number was USAF 19(604)-3073-102C.

The Ice Shelf Station was set up on May 31st. An instrument shelter, with its base 40" above the surface of the snow was erected. This shelter was also supplied by QM.R.& E., and was the same type as the one at the main station. Its serial number was DA 19-129-QM-572-81, and a Townsend Support was fitted into it; the serial number of the support was USA-QM-572-140. The shelter contained the following instruments.

One Thermograph. Ex. Signal Corps US Army (QM.R. & E.)
Man. Julian P. Friez and Sons.
Type No. ML-77. Serial No. 309
Order No. 3590-WF-43.

One Hair Hygrograph. Ex. AINA
Man. Henry J. Green.
Type No. 615
Serial No. H 2692.
AINA No. USAF 19(604)-3073-102-2B.

One Standard Liquid in Glass Thermometer
Ex. Signal Corps US Army. (QM.R.& E.)
Man. Kahlsico.
Type No. ML 7 Arctic
Range -95°F to +95°F.

One Maximum Thermometer. Ex. Signal Corps US Army (QM.R.& E.)
Man. Weksler Thermometer Corp.
Type No. ML 4 Arctic. Spec. MIL-T-11400
Range -33°F to +100°F.

One Minimum Thermometer. Ex. Signal Corps US Army (QM.R.& E.)
Man. Weksler Thermometer Corp.
Type No. ML 5 Arctic. Spec. MIL-T-11399.
Range -95°F to +85°F.

One Sling Psychrometer. Ex. Signal Corp US Army (QM.R.& E.)
Man. Cenco.
Type RSCO Cenco Yelobak. 77007.

Located west of the screen was an anemometer, set in with the cups $6\frac{1}{2}$ feet above the snow surface on May 31st. This was later lashed to the side of the screen. It came from QM.R.& E., and was a Bendix Aviation Corp. Model No. 349-N, Serial No. 6718.

INSTRUMENT PERFORMANCE

The only other weather data from the Ice Shelf of Northern Ellesmere Island was gathered in 1954. This consisted of a set of twice daily synoptic observations, and provided a guide to the setting-up of the meteorological programme in 1959. Indications are that the summer of 1959 was probably cooler than the long term means; even a cursory glance at the temperature figures shows that this summer was not as warm as that of 1954.

There were several difficulties connected with the cold weather that had to be overcome. The anemometers froze up from time to time, and had to be dismantled, cleaned and replaced. The thermograph clock at the Ice Shelf Station stopped at times; this was probably due to the cold. Below +10°F it was difficult to obtain relative humidity readings, and at times the hygrograph was used for the two-hourly measurements. Another difficulty that was not anticipated was the amount of hoar frost and rime ice that gathered on the mast, the instruments and the wires.

Following are details of the performance of some of the meteorological instruments used during 1959, with suggestions for improvements. Instruments that proved to be perfectly satisfactory, as for instance the sunshine recorder, the altimeter, and the barograph, are not discussed.

The Thermograph

Ordinary meteorological equipment is easily adaptable for use over ice surfaces in conditions such as those experienced in Northern Ellesmere Island. In these conditions, temperatures slightly above and slightly below +32°F complicate readings by causing snow to melt and refreeze on the instruments. The elements of the Friez type ML 77 thermograph were not protected or covered in any way. When snow accumulated on them it did not interfere with the readings. When the snow melted and refroze on the element, however, the ice so formed would depress the arm, and cause an error of anywhere from 1°F to 3°F. Accordingly it is suggested that this type of thermograph, with an exposed element, is unsuitable for glacial-meteorological work, and should be replaced by one in which the element is shielded or in which the element is not a curved plate upon which ice can form.

The Hygrograph

The Henry J. Green type number 615 hygrograph proved quite satisfactory. Like the thermograph, it was sometimes packed with snow during blizzards, but was easily cleaned without interfering with the hair.

The Thermometers

More accurate thermometers than those supplied by QM.R.& E. are needed for the meteorological work on the Ice Shelf Project. The thermometers used came without calibration cards, and were probably accurate only to within 0.5°F. Small differences in temperature in regions such as Northern Ellesmere Island are of great significance; it is suggested that an accuracy of at least 0.1°F is desirable. At least four each standard, maximum, and minimum thermometers, all highly accurate, should be provided in future on projects such as this, to measure screen temperatures.

The Psychron

The Bendix Model 566-2 Psychron contains a battery powering a tiny fan for cooling the wet bulb. Measuring relative humidity at low temperatures is always a problem, and the psychron seems to have no obvious advantages over a sling psychrometer at these temperatures. The lower limit of the psychron thermometers was +10°F, so that it could not be used at the end of the season.

The Beckman and Whitley Radiometers

These proved to be excellent instruments. The elements were always covered with a plastic bag when precipitation was falling, or when hoar frost was forming. Experience showed that protection of the whole instrument is necessary during high winds. Snow is driven through the holes in the casing, and clogs the

blower motor. Fine snow gets under the plastic cover, melts, and refreezes on the black plates. This melting and refreezing caused some cracking of the black paint on the total hemisphere radiometer. This was repainted, but the result was found to be unsatisfactory.

Covers should be provided for these instruments in future in order to give full protection from wind blown snow.

The Solar Radiation Recorder (Actinograph)

This model, made by the Instruments Corporation, recorded continuous incoming short wave radiation. Compared to the new Casella actinograph it is a clumsy instrument. There is no levelling device, and no cover for the dome, so that zeroing is often difficult. However, the instrument does give a satisfactory indication of the trends in incoming short wave radiation during the twenty four hour period.

The Rain and Snow Gauge

The Henry J. Green Type number 340 was of limited use for measuring precipitation. This was mainly because, during the 1959 season, almost all the precipitation fell as snow, and the snow gauge has yet to be designed that will cope with such snow falls, accompanied as they were by strong winds. At the end of several days of heavy snowfall during blizzards, for instance, the gauge was often found to be empty. When snow fell in calm conditions, the gauge could be used, but even at these times, measurements of snowfall were estimated, not only by using the gauge, but by taking random sample depths around the trailer, and measuring the accumulation at stakes AS1 to AS4.

The Micrometeorological Mast

For micrometeorological work, it seems advisable to have a specially designed mast. A tubular mast with suitable brackets for holding anemometers and thermocouples, hinged at the base to allow easy erection and demounting, is probably the best design. Great difficulty was experienced during the summer of 1959, working up the mast in high winds and low temperatures. If possible the mast should be designed so that one man can take it down to service the instruments and check the wiring. The Rohn Number 7 Tower was too heavy for this.

The Thermocouples

In an area with as much hoar frost accumulation as the Ice Shelf 20 gauge and 30 gauge thermocouple wire is far too thin for use on the mast. Hoar frost and ice at times formed to a diameter of 1" on the thermocouple wire on the mast, causing it to break. Breakages usually occurred during high winds, making servicing difficult. It is suggested that 16 gauge thermocouple wire be used in future.

The elaborate precautions for preventing radiation and contact effects on the thermocouple wire during 1959 are probably uneccessary. The wires could

be lead along the broomsticks, unshielded, and then tied to the mast. The lead-ins, however, should be kept off the snow, and strung on poles as they were in 1959. In this way, the wire is not buried in drifts, or sunk in melt pools that freeze later in the season, and breakages can be easily found and mended. It is advisable for the anemometer leads from the mast also to be brought to the trailer above the snow surface, for the same reasons.

Shielding of the thermocouples is essential. The shields used in 1959 were temporary expedients that were scrapped at the end of the season. They served their purpose, but had several faults. During high winds, the shields would be blown open, and the constant wear at the point where they were screwed to the broomsticks resulted in their becoming detached at times. If a heavier gauge aluminum is used, and the upper and lower plates connected together so that they would not be forced apart by high winds, shields such as those used during 1959 would be quite adequate. There are some firms, including Beckman and Whitley, who are producing radiation shields for thermocouples, and these specially designed shields are preferable to any that can be made up from aluminum.

The Anemometers

The Henry J. Green anemometers Type No. 323-F represents a good compromise between a highly accurate, very delicate and extremely expensive anemometer, and a crude, inaccurate, cheaper model. It is quite suitable for glacial-meteorological work, but requires considerable care and attention. At one time, in early September, it was necessary to dismantle and clean each anemometer once every few days. The 10 metre anemometer, unfortunately, froze up at this time, and could not be detached from the top of the mast.

In this type of anemometer, a spindle revolves in a socket, and drives a gear that sends over a relay. Due perhaps to differential expansion, the bottom of the spindle tended to bind in the socket. The bottom of the spindle, where it rested in the socket, also tended to rust, and even a thin layer of dirt and rust would be enough to stop it rotating. The anemometer spindles were periodically cleaned in gas, and filed clean. Light machine oil was used for lubrication, but at temperatures below 0°F, even this tended to thicken and clog the spindle. Graphite was used for lubrication, but it is suggested that an extremely light, low temperature oil be used on the bearings and gears of these instruments.

The Potentiometer

The Gray Instrument Co. potentiometer Model Number E3067 proved to be a highly reliable instrument. When used outside the trailer in low temperatures, in the latter part of the season, it was difficult to zero and erratic in its readings. This was no doubt due to the standard cell, in a worn out condition, being influenced by the cold. For this potentiometer it is advisable to replace the standard cell and all other batteries before the instrument is used again. In conditions such as those experienced in Northern Ellesmere Island, the useful life of the standard cell, even if the instrument is kept in a heated trailer most of the time, is no more than one season.

Visibility

The following markers were used to determine visibility. Since the expedition was in continuous daylight until September 6th, darkness was not a problem.

Marker	Visibility
Instrument Shelter not visible	10 yards
Instrument Shelter visible	50 yards
Ablation stakes north and south of the trailer, clearly visible	250 yards
First ridge north of the trailer The "Strand Crack Ridge"	¼ mile
First lake north of the trailer	½ mile
Instrument Shelter on shelf	1 mile
Line of lakes west of the station	2 miles
Cone of Ward Hunt Island	3 miles
Both ends of Ward Hunt Island, and the line of hummocks at the edge of the shelf	5 miles
Western shores of Disraeli Bay	8 miles
Cape Albert Edward and Cape Alexandra showing clearly	15 miles
Whole coastline visible	30 miles

BREAKAGES

The following instruments, all belonging to QM.R.& E., were broken during the summer of 1959.

One Maximum Thermometer. Type ML 4. Spec. MIL-T-11400
One Standard Thermometer. Type ML 7. Kahlsico Arctic.

These two thermometers were broken en route to the Ice Shelf Station on May 31st.

One Eppley Pyrheliometer. No. 2683. EMM 46800

The stem holding the element of the pyrheliometer was broken at base camp.

SUGGESTIONS FOR NEXT SEASON'S METEOROLOGICAL PROGRAMME

A review of the 1959 meteorological programme suggests several possible improvements for work during 1960.

The present main meteorological station is located in the middle of the ablation stake grid, on the northern edge of the Ice Rise. It would appear that the area of the Ice Rise, the Ice Shelf and Ward Hunt Island experiences much local weather. In order to investigate these local conditions more fully, it would be advisable to erect an instrument screen, and take some micrometeorological observations at another point on the Ice Shelf. The survey line, some twelve miles west of the present station, would be a good location. A station established in the centre of this line would be well away from the local influence of Ward Hunt Island and the Ice Rise. An elaborate micrometeorological and radiation installation such as that the main station would not be needed. An observer stationed there could take ablation and other glaciological measurements in addition to doing the weather work.

An instrument shelter should be erected on Ward Hunt Island, and synoptic observations carried out at least twice daily. There is a shelter in the 1954 cache; a request for this to be dug out, erected on the island, and instruments installed and read, met with no response in 1959. If the screen was erected, the Camp Commander, cook or radioman could take the synoptic observations in addition to their normal work. By running the main station for twelve hours, re-opening the 1959 Ice Shelf station, putting up a screen on Ward Hunt Island and establishing another station on the Ice Shelf, somewhere along the survey line, a much better idea of the synoptic and micrometeorological picture in the area could be obtained.

This programme could be carried out by the same number of men as in 1959. The main station and the survey line station could each be manned by one observer, who would be responsible for glaciological observations as well as for routine weather observations. It is suggested that, instead of employing a highly paid meteorologist to work as a weather observer, that a meteorologist go in at the beginning of the season, establish the stations, check them out and see that they are running correctly, and then hand over the programme to be run by competent weather observers.

The amount and type of equipment used during 1959 was, on the whole, satisfactory. The following is a list of extra equipment and supplies needed, as well as replacements for damaged parts, and for expendable equipment.

Six hundred feet of two conductor wire for connecting the four mast anemometers to the buzzer box in the trailer. These leads should be carried to the base of the mast on poles to avoid their sinking into the snow during the melt.

Two hundred and fifty feet of two conductor wire for connecting the radiometers to the potentiometer. This length will be needed if the radiometers are located approximately one hundred and fifty yards from the trailer.

One hundred and fifty feet of two conductor wire to connect the Eppley pyrheliometer to the potentiometer.

Six hundred feet of thermocouple wire for reading temperatures at four levels on the mast. This should be 16 gauge copper/constantan wire if possible, and should be strung on poles from the trailer to the base of the mast.

One hundred and fifty feet of thermocouple wire to connect the net exchange radiometer to the trailer. This should preferably be 20 gauge copper/constantan.

Four radiation shields for the mast thermocouples. Beckman and Whitley manufacture a shield that would probably be suitable.

A Wind Direction Indicator. This is preferable to the method of using a flag and an azimuth.

One spare anemometer. This should be Henry J. Green Type 323-F.

A complete tool kit. The minimum requirements for this are one claw headed hammer, one wood saw, two large and two small screwdrivers, one pair needle nose pliers, one pair heavy pliers, a watchmaker's screwdriver set, two adjustable wrenches, two open ended wrenches, one hand soldering iron, silver and resin cored solder and flux. Also needed are several rolls of masking tape, electrician's tape, and Scotch Tape. A fine lubricating oil for the anemometers is needed; a lubricant good down to at least -10°F should be obtained. Hoar frost on the actinograph, sunshine recorder and Eppley pyrheliometer was a problem in 1959. Glycerine should be taken in to coat the bulbs of these instruments.

Office supplies; more daily weather sheets similar to those used during the summer of 1959 will be needed. An adequate supply of radiation sheets was left over for use in 1960. A set of US Weather Bureau Psychrometric Tables is also needed. Scrap paper, notebooks, pencils, etc. are also needed.

A tape measure, graduated in centimetres and inches, and a metal tipped metre stick should be obtained for the meteorological programme.

A flashing light device to replace the present buzzer box as a wind speed indicator would make life more livable in the trailer. Flashlight batteries will be needed for this or for the buzzer box, and also for the psychron.

At least one dozen wooden dowels to carry leads to the mast from the trailer will be needed. Their diameter should be 1" or less, so that they can be set in quickly with the SIPRE Ice Thickness Drill.

A Dewar flask will be needed to hold an ice bath at the terminals of the Gray potentiometer when thermocouples are being read.

Spare nibs should be obtained for the Henry J. Green hygrographs and barograph.

Extra wicks and muslins for the sling psychrometer and the psychron should also be obtained.

A supply of extra sunshine cards (curved) for use during the summer of 1960 will be needed. Three cards are needed every twenty four hours.

A window for the Henry J. Green Type No. 510 hygrograph is needed to replace the one broken in 1959.

A low resistance switch will be needed for the thermocouple connection inside the trailer.

PRESENT CONDITION AND LOCATION OF THE METEOROLOGICAL EQUIPMENT USED DURING THE 1959 PROGRAMME.

The meteorological equipment used during 1959 was derived from three sources - QM.R.& E., GRD, and AINA. Their disposal was as follows.

QM.R.& E. EQUIPMENT

When the station was dismantled on September 8th - 9th, all QM.R.& E. equipment, in good condition, was handed over to Private First Class Thomas Turnbull. It comprised the following:

No.	Instrument	Type	Serial No.
Two	Thermographs	ML 77 (Complete with clocks)	269 (EPRD 2-58), 309.
One	Wind Indicator	349-N (Complete with base)	6718
One	Hand Anemometer	A2(Davis Man. Co.) (Complete with case)	None
Two	Maximum thermometers	ML4	None
Two	Minimum thermometers	ML5	None
Two	Standard thermometers	ML7	None
One	Actinograph	5-3850 (Complete with clock number 202095)	205
Two	Instrument shelters	S-101/UM	DA-19-129-QM-572-84, and 81
Two	Townsend supports	MT-1426/UM	USA-QM-572-133, and 140
One	Sling Psychrometer	77077 Cenco	None

GRD EQUIPMENT

The following GRD instruments were handed over to the Project Leader when the main meteorological station was closed. They were in the condition as received, except that the batteries and the standard cells were worn out.

Two Gray potentiometers, Model No. E3607, Serial numbers 15146 (GRD 19732) and 15147 (GRD 19734).

The other GRD instrument, the Wallace and Tiernan Altimeter (Model FA181, Serial No. 12079B GRD 16757) was sent back to the Ice Shelf on September 15th, via the AINA Field Co-ordinator at Thule.

AINA EQUIPMENT

Before being packed up, all AINA meteorological equipment was cleaned, and the AINA serial numbers were marked on the instruments with "Magic Marker", in addition to having decals attached.

On the cardboard boxes in which the instruments were packed was marked their contents, the AINA serial numbers of the instruments, and USAF ELLESMERE ISLAND ICE SHELF PROJECT. MET. PROGRAM.

The following equipment was left in Northern Ellesmere Island.

1. Measuring stick for the Type 340 Rain Gauge. An extra one should be ordered for next season.

2. The meteorological mast, still in position, with two clamps attached to it at the one metre and the three metre levels, and a type 323-F anemometer base still mounted on one clamp.

3. The Net Exchange Radiometer. The power leads of these instruments were cut back where they had frayed, the instrument case had been removed and all snow and ice cleaned from the blower motor. It was requested that this instrument be brought back for storage in Thule when the party withdraws in November. I retain the sheet showing the characteristics of this instrument.

This is the Beckman and Whitley Thermal Radiometer Model N188-19, Serial No. 220, AINA No. USAF 19(604)-3073-100B.

The following instruments were brought back and stored at AFCRC Detachment 4 Warehouse at Thule Air Base. There are eleven pieces in all, containing the following.

1. A box containing the rain gauge, complete. This is Henry J. Green type No. 340 AINA No. USAF 19(604)-3073-102A. There are some small holes in the outer can, but this does not impair its use.

2. One five in one ration box containing one hygrograph type 615, serial number H2692, AINA USAF 19(604)-3073-102-2B. The nib of this instrument is sprung. This and the other hygrographs have the recording arm tied to the posts, the hairs disconnected, and wrapped in tissue paper, and the instrument itself in a plastic bag.

3. One five in one ration box containing one hygrograph type 615, serial number H2691, AINA USAF 19(604)-3073-102-1B. This instrument served as a spare during the season and was never used.

In the same case were four bottles of Henry J. Green Recording Ink, and three packages containing hygrograph charts (Type 58). There are 137 charts in all, and also 39 barograph charts (Type 15MW) packed in the same case.

4. One base for anemometer Type 323-F mounted on a wooden footing.

5. One package of Canadian Department of Transport weather sheets.

6. The base for Eppley Pyrheliometer No. 2168 mounted on a broomstick.

7. One five in one case containing Eppley Pyrheliometer Globe No. 2168(K=2.39). This globe is packed in a KLIM tin, with all data noted on top, and 10" of two conductor wire still attached to it. In the same case is the complete assembly of the Lambrecht Sunshine Recorder, Model No. 1605, Serial No. 24501, with instructions. The globe is packed in a KLIM tin, with the AINA No. USAF 19(604)-3073-101 noted on the tin. The decal has come off the base of the recorder, and the AINA number is marked on masking tape affixed to the base. Also contains 183 straight and 103 curved sunshine cards, 249 special radiometer sheets for the Eppley, and 241 sheets for the B & W Radiometers.

8. One five in one case containing psychron, Bendix model 566-2, AINA USAF 19(604)-3073-105. One spare nib is in the case with the instrument. In the same box is the barograph, Henry J. Green Model no. 565, Serial no. B808, AINA USAF 19(604)-3073-102C. The barograph nib has been cleaned, the arm disconnected, and tied to the post.

9. One five in one case containing one hygrograph type 615, Serial no. H2693, AINA USAF 19(604)-3073-102-3B. The glass window of this is broken, and will have to be replaced. Instructions for hygrographs are packed with this. In the same box are packed the buzzer box for the anemometers, and two hygrograph clocks.

10. Four anemometer cups for Type 323-F.

11. One C-ration box containing four anemometer stems. All have decals on the dials, and AINA numbers marked on the stems. They are Type 323-F, Serial numbers A998-1001, AINA Serial numbers USAF 19(604)-3073-103A to D. These instruments were cleaned in gas before packing, but should be cleaned again before use and checked with the hand anemometer. Two stands and three mounting pintles are packed with these anemometers. 103D has a pintle attached, and 103B has a base attached.

The following instrument was brought back to the AINA office in Boston. Beckman and Whitley Total Hemisphere Radiometer, Model H188-19, Serial Number 229, AINA No. USAF 19(604)-3073-100A. This instrument needs recalibrating and overhauling, and will have to be returned to Beckman and Whitley in California. The last quoted cost for overhaul and recalibration was $75.00. I retain the sheet showing the characteristics of the instrument.

Date Due

MAR 23 '81

PRINTED IN U. S. A.

SUMMARY

This report contains details of all equipment drawn from various sources, and used during the Ellesmere Island Ice Shelf Project, 1959. A complete account of the equipment has been given, and all possible information provided to help in the setting up of the meteorological programme in 1960.

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